High transmission tender X-ray energy range monochromator based on Multilayer-coated blazed grating

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A multilayer coating on top of high line density blazed gratings can increase its diffraction efficiency up to one order of magnitude for a selected diffraction order. In combination with a multilayer coated pre-mirror in a plane grating monochromator (PGM) conception the total instrument transmission can be increased by two orders of magnitude. In our developments on multilayer-coated blazed gratings (MLBG) we have reached experimentally efficiency up to 60% [1,2] in the tender energy range where a single layer coated grating would demonstrate only few percent efficiency. The key factor of the high performance of a MLBG lies in the correct optimization of both multilayer and grating profile parameters with respect to each other [3]. After several successful prototypes the first real MLBG was designed and installed in the c-PGM at the U41-TXM-beamline at BESSY-II [4].

In our contribution we present our recent research on MLBGs with extended energy region up to 8.5 keV. The experimentally measured efficiency on our first prototype high line density Ni/B4C ML coated grating demonstrated extraordinarily high value of 60% at 7 keV. One of the main challenges for application of MLBGs in PGMs together with a ML coated pre-mirror is caused by asymmetric beam propagation inside the multilayer on top of the grating where it has a slightly different path with respect to the plane mirror case. In order to fulfill the exact PGM geometry the proper optimization of ML period thicknesses for mirror and grating should be carried out carefully in the whole working energy range. Our research findings emphasize that the corresponding d-spacing deviation between MLM and MLBG could reach up to several tenths of nanometer and becomes stronger with higher energy. Several possible solutions for PGMs with ML coated optics which are suitable both for undulator as well as dipole based beamlines will be presented and discussed.

[1] A. Sokolov et al., Opt. Express 27(12), 16833 (2019)

[2] F. Senf et al., Optics Express 24(12), 13220 (2016)

[3] Q. Huang et al., Opt. Express 28, 821 (2020)

[4] S. Werner et al., Small Methods 7(1), 2201382 (2023)